Part

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Calibration of FREIGHTS

Calibration of FREIGHTS Model

Introduction

The FREIGHTS model was used to project growth for redwood and Douglas-fir stands. Calibration of the Freights model required an assessment of commonly used growth and yield models and actual yield estimates on Pacific Lumber Company lands. Ultimately, we wanted to project growth based on localized data for both intensively and extensively managed stands between 10-100 years of age.

Obtaining Local Data

Age, volume, and site index were determined for second growth stands on Pacific Lumber Company lands. This information was used as a baseline to calibrate the growth projection in Freights. Sufficient local data was unavailable to calibrate the intensive management projection.

Management History

Historically, most of the PL ownership was logged during the late 1800's to early 1900's. Most of the redwood and Douglas-fir greater than 36" DBH was removed. Where present, other whitewoods and trees less than 36" DBH were left. However, few of these trees remain probably due to fires following harvest. Subsequent management of these stands was minimal. There are some records of tree planting in the 1930's when PL ran a tree nursery; however, it is not known where and how much was accomplished. There are no records of tree improvement, precommercial thinning, or control of competing vegetation. We concluded that existing second growth stands received little or no management. We refer to these stands as "extensively managed."

"Intensively managed" stands includes areas that were clearcut, followed by one or more of the following treatments: site preparation, planting, genetically improved stock, precommercial thinning, and control of competing vegetation. One site along the Eel River in Scotia was converted from redwood forest to farmland in the mid- to late 1800's. Between 1980-1982 this land was replanted to redwoods at 10 feet by 10 feet spacing. Subsequent herbicide treatments were applied to control grass and brush. Plots taken in 1994 and 1995 provide a basis for comparison of basal area, average diameter and volume.

Determination of Age and Volume

Age of second growth stands was determined from harvest history records. This information indicated the decade in which the original harvest occurred. Current volume was determined using the 1986 inventory data stratified by timber type. Enough data was available for the redwood forest type to estimate average stand volume by age class for stands between 20 and 80 years of age. Insufficient data was available to estimate ages of second growth Douglas-fir stands.

Site

Site index for these stands was determined from an analysis of over 160 measured site trees distributed across the ownership. This information was collected as part of an ongoing process of monitoring log quality on active timber harvest plans. Typically, five site trees were measured on every harvested unit. Site index was calculated using Krumland and Wensel site curves. Tree locations were mapped and transferred to the GIS system for analysis. Site trees were classified by site class from soil-vegetation maps. The average site index was determined for each major site class. Most of the site trees were on soils classified as Site II. There is insufficient data to validate Site I, III or IV. The average site index for Site II was 100 for redwood and 123 for Douglas-fir (Height at 50 years Krumland & Wensel). The site index of the Scotia Tree Farm is about 180 (45 feet at 15 years).

Evaluation of Yield Projections

The three primary yield projection methods used in the redwood region are Empirical Yield Tables for Young-Growth Redwood (Lindquist and Palley 1963), CRYPTOS (Krumland and Wensel) and Yield, Stand and Volume Tables for Douglas-Fir in California (Schumacher 1930). Another model developed by M. Barrett in 1988 is used to project growth of redwood sprouts following various levels of overstory removal.

Estimates of yield in both the Lindquist and Palley, and Schumacher yield tables have been considered overly generous since they represent “full” or “normal” stocking. Many commercial stands today do not achieve these standards due to differences in management history. These yield tables represent “better than average” results from extensive management assuming vigorous regeneration, minimal brush competition, adequate distribution and full occupancy of the site.

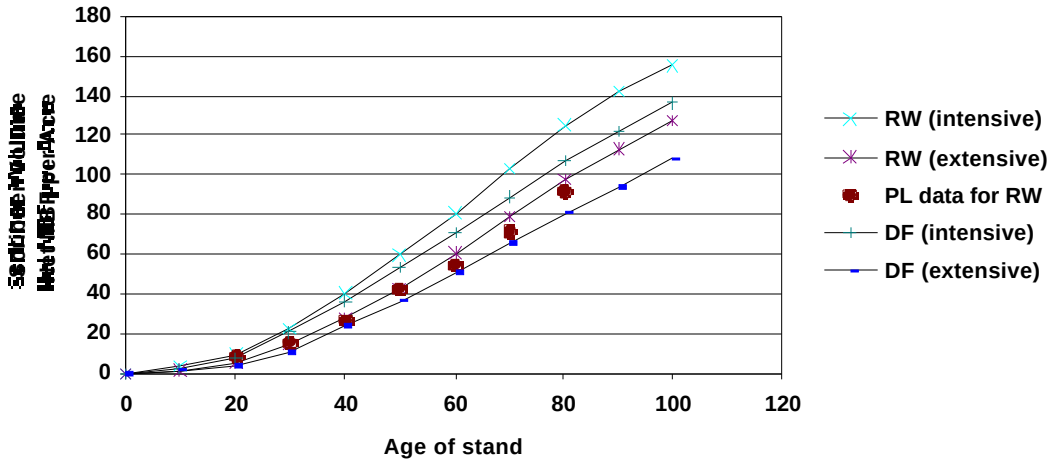
CRYPTOS is an excellent short-term growth projection model for second-growth, managed stands. Validation studies have shown short-term growth estimates within ±10% of actual growth (JDSF). Long-term growth projections (such as those required for the SYP) have not been validated due to lack of data. We are unaware of any validation efforts of the Barrett redwood sprout model.

The FREIGHTS model is similar to CRYPTOS but with two major enhancements: 1) projection of sprout and seedling growth, 2) and more sophisticated harvesting routines. FREIGHTS was used as the growth and harvest simulator because of its speed, reasonable short term projections and realistic harvesting routines. Validation efforts are currently underway.

Calibration of FREIGHTS

FREIGHTS was calibrated by iteratively adjusting the initial trees per acre by species, DBH and height immediately after regeneration harvest. This calibration was implemented to match, as closely as possible, the extensive management volume estimates for redwood stands on PL ownership. The intensive management growth curve for redwood stands was calibrated to be about 35% greater than the extensive management curve at age 60. This is a conservative estimate of improved yields based on literature review. Due to lack of local Douglas-fir data the Douglas-fir curve was calibrated to match CRYPTOS Douglas-fir yields for the estimated site index (123 feet on Site II). The intensive management growth curve for Douglas-fir stands was calibrated to be approximately 35% greater than the extensive management curve at age 60. Figure 1 provides a graphical representation of a redwood and Douglas-fir yield projections under intensive and extensive management.

Figure 1. Projection of Yields for Redwood and Douglas-fir under Intensive and Extensive Management Regimes



Justification of Calibration

In the following paragraphs, we discuss the reasons for modifying the model both for extensive and intensive management practices.

Extensive Management

Under an extensive management regime planted trees are provided to meet initial stocking. No other treatments such as site preparation, tree improvement, competing vegetation control and precommercial thinning are applied. Calibration of FREIGHTS to match PALCO's redwood extensive management curve is based on local data. These growth estimates match a CRYPTOS simulation that used the Barrett model output following clearcutting. Furthermore, Louisiana-Pacific at Crannell has a localized yield table with remarkably similar volumes.

The Douglas-fir extensive management calibration to match CRYPTOS yields is considered a reasonable baseline in the absence of local data.

Intensive Management

The intensive management regime includes site preparation, planting improved quality seedlings, control of competing vegetation, and precommercial thinning. The intensive management calibrations were established after review of PL data and literature regarding intensive forest management practices.

PALCO data. The Scotia Tree Farm is a 12-15 year old plantation that has appeared to benefit from earlier grass and brush control. Average diameter is 8.65" DBH with range 2-16.3" DBH. Average height is 34', ranging between 10-60 feet. Average trees per acre is 550. Basal area ranged between 86-393 with average of 238 ft2/ac. Volume is 6 MBF/ac with range between 1-13 MBF/ac. At current growth rates this stand will have an average DBH of 13", height of 50 feet, basal area of 500 ft2/ac and 16.5 MBF/ac in 5 years. Compared to Lindquist and Palley for site 180, age 20 at 11.4 MBF/ac. Lindquist and Palley volumes are International 1/4 rule and were converted to Scribner. This represents a 25-45% improvement in yield due to planting and control of competing vegetation.

Literature review. Additional literature review indicates volume increases from 30 to 800% due to intensive management practices. Knowe (1995) reported 33-100% reduction in DBH growth of 7-11 year old Douglas-fir trees in response to competition with big leaf maple in Oregon. He also noted a 35-75% reduction in height growth. Eleven year old Douglas-fir trees not in competition with sprouting madrone had 52-300% greater stem volume than those trees experiencing high competition (Wang et al). Competition from brush reduced Douglas-fir stem volume to 12.5% of non-competing 5 year old trees (Tesch et al 1993). Four year old Ponderosa pine plots with brush control had 176% more volume than plots without brush control (Powers 1992).

- Gains due to tree improvement have been substantial particularly in some hardwood species. Weyhaesauer has reported 30-50% gains in Douglas-fir from genetic selection. Research efforts on redwood are still in their infancy. Simpson anticipates a 10-15% increase in stand volume over a rotation due to their efforts in tree improvement.

- Literature review of precommercial and commercial thinning in redwood has not shown increases in stand volume production. However, these processes have concentrated volume growth on fewer, larger stems resulting in value growth improvements.

- No literature was available which addressed the synergistic or cumulative effect of intensive management practices on yield. Potentially large increases could be captured using genetically improved stock, control of competing vegetation, and stocking control.

- Almost no literature was found regarding effects of intensive management over the longer term (20-100 years).

Based on the available information, we felt a conservative approach to calibration for intensive management was warranted. FREIGHTS was calibrated to achieve a 35% improvement over extensive management at age 60. This is equivalent to a 15% improvement in redwood yield at age 60 compared to Lindquist and Palley site 160. Douglas-fir intensive curves were also calibrated to achieve a 35% improvement over extensive management at age 60 until we are able to develop local information.

Uneven-aged Management

FREIGHTS is used to project growth under uneven-aged management as well. Since no long term data is available we did not make any additional adjustments. Adjustments applied to even-aged strategies were also applied to the uneven-aged.

Conclusion

The FREIGHTS model was calibrated to reflect local data where available. Data from other sources was used where necessary but conservative estimates are warranted. As part of our long-term monitoring process PL is establishing study blocks to address the effects of intensive management practices. This data will be used to help refine future planning efforts.

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